NRC Bulletin 2003-01: Potential Impact of Debris Blockage on Emergency Sump Recirculation at Pressurized-Water Reactors

June 30, 2003

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GSI-191 Status .....Ralph Architzel
Presentation on Bulletin 2003-01.....John Lehning
Response to Bulletin Addressee Questions.....Staff
Stakeholder Questions.....Staff

Opening Remarks

Suzanne C. Black

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Status of Generic Safety Issue 191, Assessment of Debris Accumulation on PWR Sump Performance

Ralph Architzel
NRR/DSSA/SPLB

GSI-191 Status

- Issue Determined Credible by RES and in Regulation/Guidance Development Phase
- Bulletin is intended to address near-term interim compensatory measures
- Subsequent generic letter (which will undergo public comment - October 2003) to address longer-term evaluations and corrective actions
- Regulatory Guide 1.82 Revision 3 - September 2003
- Industry Evaluation Guidelines - Fall 2003

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John Lehning
NRR/DSSA/SPLB
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Presentation Outline

- Purposes of Proposed Bulletin
- Background on Debris Blockage Issues
- Discussion of Debris Blockage Effects
- Basis for Issuing Proposed Bulletin
- Information Request
- Available Guidance for Sump Analysis
- Example Interim Compensatory Measures
- Backfit Discussion

Purposes of Proposed Bulletin

- Inform PWR licensees of NRC-sponsored research demonstrating the potential for recirculation sump screen blockage
- Inform PWR licensees of additional adverse effects of debris blockage of necessary flowpaths upstream and downstream of screen
- Request information from PWR licensees describing:
  - Compliance with existing requirements

    – OR –
  - The implementation of interim compensatory measures
- Require a written response per 10 CFR 50.54(f)

Background

(USI A-43)

- Unresolved Safety Issue A-43 examined screen blockage for PWRs and BWRs (1979-1985)
  - Issue was closed based on technical knowledge now known to be incomplete
  - NRC recognized that 50% blockage assumption was usually nonconservative, but a backfit was not justified for licensed plants by value/impact analysis
  - NRC updated regulatory guidance for future plants based on USI A-43 technical findings

Background

(BWR Strainer Issue)

- Strainer blockage events at BWRs in mid-1990s demonstrated inadequacy of USI A-43 resolution
  - Barsebäck Unit 2, Perry Unit 1, and Limerick Unit 1
- NRC issued a number of generic communications in response to these events
  - e.g., Bulletin 93-02, Bulletin 95-02, Bulletin 96-03
- NRC and Industry performed research and developed guidance on strainer blockage
- BWR licensees installed larger, more effective strainers and NRC has concluded that BWR licensees have addressed these Bulletins

Background

(Genesis of GSI-191)

- As compared to USI A-43 findings, BWR strainer blockage research showed that:
  - More debris could be generated
  - Debris could be finer
  - Fibrous plus particulate debris could lead to significantly higher head losses
- The NRC opened Generic Safety Issue 191, "Accumulation of Debris on PWR Sump Performance" to re-assess PWR sump adequacy in light of the new findings

Discussion

(Phenomenology)

- Debris Generation
  - Jet impingement, pressure waves
  - Containment temperature/humidity, flooding
  - Pre-existing debris (e.g., dirt, dust, foreign material)
- Debris Transport
  - Spray/break flow entrains debris and washes it down to containment pool
  - Suspended debris is drawn to sump when recirculation begins
- Debris Accumulation and Head Loss
  - Suspended debris tends to form a uniform bed
  - Debris bed acts as a filter, increasing head loss

Discussion

(Debris Blockage Concerns Addressed in Bulletin)

- Sump Clogging
- Sump Screen Structural Integrity
- Upstream Blockage of Containment Drainage Flowpaths
- Downstream Blockage of ECCS and CSS Recirculation Flowpaths

Discussion

(Sump Clogging)

- RES's technical assessment of GSI-191 culminated in a parametric study
- GSI-191 Parametric Study mechanistically modeled debris blockage for 69 "cases," which correspond to operating PWRs
- Study showed that sump clogging is a credible concern for the population of domestic PWRs
  - i.e., ECCS and CSS pumps could lose NPSH margin
- Limitations of the Study with respect to data and modeling assumptions prevented identification of individual plants where vulnerabilities exist

Discussion

(Structural Integrity)

- As a result of 50% blockage assumption, PWR sump screens typically underestimate structural loadings associated with debris blockage
- Mechanistically determined debris beds may result in deformation or loss of screen integrity
  - Debris intrusion could lead to blockage or clogging of components downstream of sump screen
- Strainer deformation event has occurred at a BWR (Perry Unit 1)

Discussion

(Upstream Blockage)

- Water may be prevented from reaching sump if debris blocks containment drainage flowpaths
  - Flow constrictions (i.e., chokepoints) are primary concern, such as floor and cavity drains
- Holdup of recirculation sump inventory reduces available NPSH to ECCS and CSS pumps, thereby reducing assurance they will function successfully
- A number of LERs (cited in bulletin) demonstrate credibility of concern

Discussion

(Downstream Blockage)

- Inadequate sump configurations could allow debris to pass through or bypass screen
  - Intended openings may be too large (e.g., diagonals of a rectangular mesh, limiting flow restriction neglected)
  - Sump screen may have gaps or breaches
- Debris that passes through unanalyzed screen openings could clog downstream flow restrictions
  - e.g., HPSI throttle valves, pump clearances, fuel assembly inlets, and containment spray nozzles
- Numerous events (see GL 98-04) demonstrate credibility

Basis for Elevating GL to Bulletin

- Several emergent items have increased urgency of the staff's resolution efforts on GSI-191:
  - Davis-Besse LER declared sump inoperable
    - Debris could block more than 50% of screen surface
    - 6" x 3/4" gap found, likely present from construction
    - Information provided by licensee in LER and public meeting showed assumptions in the GSI-191 Parametric Study were not conservative for Davis-Besse
  - Another Davis-Besse LER declared HPI pumps inoperable due to potential blockage of pump internals
  - NRC-sponsored risk study published concerning operator recovery actions from sump clogging
    - Potential interim risk could be reduced significantly through proper mitigative measures

Requested Information

- Within 60 days of date of the Bulletin, PWR licensees are requested to provide the information requested in either Option 1 or Option 2:
  - Option 1: State that the ECCS and CSS have been analyzed with respect to the debris blockage effects identified in the bulletin and are in compliance with existing regulatory requirements
  - Option 2: Describe any interim compensatory measures that will be implemented to reduce the risk which may be associated with a potentially degraded ECCS or CSS until an evaluation to determine compliance is complete. Provide justification if any of the example compensatory measures in the bulletin will not be implemented and for any extended implementation schedules.

NRC Guidance for Sump Analysis

- Generic Letter 91-18, Rev. 1, provides guidance on degraded and nonconforming conditions, and the need for interim compensatory measures
- Parametric Study (NUREG/CR-6762, Vol. 1) provides a simplified framework that could be updated with plant-specific info
- DG-1107 (future Rev. 3 to RG 1.82) provides current regulatory positions on sump adequacy
- NUREG/CR-6808 is a knowledge base report intended to serve as a reference for plant-specific sump analyses

Examples of Interim Compensatory Measures in Bulletin

- Operator Training on Sump Clogging
- Procedural Modifications to Delay Recirculation
- Ensuring Availability of Alternative Water Sources
- More Aggressive Containment Cleaning/Foreign Material Controls
- Ensuring Containment Drainage Paths are Unblocked
- Ensuring Sump Screens are Free of Adverse Gaps and Breaches

Backfit Discussion

- Bulletin requests information only
  - No backfit is being imposed
- Bulletin requires response per 10 CFR 50.54(f) for the purpose of verifying compliance with existing applicable regulatory requirements
  - 10 CFR 50.46(b)(5)
  - 10 CFR Part 100, 10 CFR 50.67
  - GDCs 35, 38, and 41
  - Technical specifications
  - Other plant-specific licensing basis requirements
- Information request is based on new information on compliance with existing requirements